HP 3000 SERIES II
COMPUTER SYSTEM
MANUAL OF STAND-ALONE DIAGNOSTICS

STAND-ALONE HP 30103A (2660A)
FIXED HEAD DISC DIAGNOSTIC

Diagnostic No. D428A

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I.   INTRODUCTION

The fixed head disc diagnostic is a stand-alone program
written in SPL/3000 and prepared with SDUP as a cold
loadable diagnostic. The diagnostic will verify the
correct operation of the fixed head disc subsystem.

II. MINI OPERATING INSTRUCTION

Cold load standalone diagnostic tape
D000 FIXED HEAD DISC DIAGNOSTIC (HP D428A.00)
P008 ENTER DEVICE NUMBER
(Enter disc DRT number in decimal)
P009 ENTER FIRST AVAILABLE TRACK
(Enter first track - usually 0)
P010 ENTER LAST AVAILABLE TRACK
(Enter 255 for 2 MBYTE disc. 511 for 4 MBYTE disc)
D14 SET SWITCH REGISTER
(Set bits 0 and 15, press run)
E109
E001 NSW 1000000000000001
(No protected tracks, diagnostic runs approximately 40 minutes
for 4 MBYTE)
D006 END OF PASS 001

III. REQUIREMENTS

The fixed head disc diagnostic will run on a minimum HP 3000 Series II
Computer System with a fixed head disc.

IV.   DETAILED OPERATING INSTRUCTIONS
1.   Mount the cold loadable I/O standalone tape containing the fixed
     head disc diagnostic on DRT 6 unit Ø.
2.   Set the switch register to %3006, then simultaneously
     depress the ENABLE and LOAD switches.

     A short length of tape should load and the CPU will halt.
3.   Set the switch register to the diagnostic number of the
     fixed head disc diagnostic.
4.   Press RUN.
     The tape should load and rewind.
5.   Press RETURN on the console, the message:
     DØØØ FIXED HEAD DISC DIAGNOSTIC (HP D428A.XX)
     PØØ8 ENTER DEVICE NUMBER

6. Enter the decimal device number of the fixed head disc controller. Press RETURN.

7. The message:

   P009 ENTER FIRST AVAILABLE TRACK

   Will be printed.

8. Enter the first track to be tested, usually 0. Press RETURN

9. The message:

   P010 ENTER LAST AVAILABLE TRACK

   Will be printed.

10. Enter the last track to be tested.

    255 for 2 MBYTE disc

    511 for 4 MBYTE disc

    Press RETURN.

11. The message:

    D14 SET SWITCH REGISTER

    Will be printed. The CPU will halt. CIR=%030364

12. Set the switch register bits 0 and 1. Press RUN.

13. The message:

    D15 SELECT SECTIONS

    Will be printed.

14. Set the B switch register bits 1 through 6. Press RUN.

TABLE 1. SWITCH REGISTER AND SECTION SELECT OPTIONS

SWITCH REGISTER	
BIT	**FUNCTION**
0	Select external switch register
1	Select section select register
10	Suppress error messages
11	Loop on last step
12	Halt on error
13	Halt at end of step
14	Halt at end of section
15	Halt at end of program

SECTION ELECT REGISTER	
BIT	**FUNCTION**
1	Select section 1
2	Select section 2
3	Select section 3
4	Select section 4
5	Select section 5
6	Select section 6
7	Select section 7

HALT CODES	SEGMENT	MEANING
%030364	3	Halt for switch register
%030365	3	Halt for section select
%030366	3	Halt for restore switch register
%030372	3	Halt on error
%030373	3	Halt at end of step
%030374	3	Halt at end of section
%030375	3	Halt at end of diagnostic

15. The message:

    D16 RESTORE SWITCH REGISTER

    Will be printed.

16. Set the switch register bits 0 and 15. Press RUN.

17. The message:

    E109

    E001 NSW 1000000000000001

    Will be printed designating no tracks are protected.

    The diagnostic runs approximately 40 minutes for 511

    tracks at the end the message.

    D006 END OF PASS XXX

    Will be printed and the diagnostic halts.

    CIR = %030375.

    Press RUN to continue.

TEST SECTIONS

The diagnostic is divided into seven sections. Sections 1 through 7 each consist of a logical set of tests or functions. Each test or function is a uniquely numbered step.

A control section makes up the outer block of the diagnostic and controls its operation. It calls numbered sections as procedures selectively and in sequence according to switch settings selected during configuration.

Summary of Test Sections

There are seven test sections:

Section 1 verifies the proper execution of the instructions TIO and CIO to disc. Status bits, tracking and addressing conditions are tested.

Section 2 checks read/write functions with Cyclic Redundancy Check (CRC) disabled.

Section 3 checks CRC operation and read/write functions with CRC enabled.

Section 4 verifies read operation following write operation.

Section 5 performs surface analysis and verifies proper head selection.

Section 6 performs random read and write operations of variable numbers of sectors with changing data patterns.

Section 7 tests the power-fail protection capability of the Fixed Head Disc.

Summary of Test Section Steps

Table 1 summarizes the steps performed in sections 1 to 7.

Table 1. Test Steps

Step Number	Function
	Section 1
101	Test response to Test 1/0
102	Test response to Control 1/0
103	Test status bit 0; Start 1/0 allowed
104	Test status bit 1; RIO/WIO allowed
105	Test status bit 2; interrupt request
106	Test status bit 3; disc not ready (special manual operator procedures required; will only run if switch 7 is ON).

Table 1. Test Steps (Continued)

Step Number	Function
	Section 1 (Continued)
107	Test status bit 7; track address out of bounds
108	Test status bit 5; abort
109	Test status bit 8; attempt to write on protected tract (one error will occur if there are NO protected tracks)
110	Test status bit 9; Arc address out of bounds (Arc 63)
111	Test that Arc number increments, then gets reset to 0 after highest Arc address, 31
	Section 2
204	Write first available track sector 0 with worst case pattern*
205	Write first available track sector 7 with worst case pattern for two sectors
206	Read first available track sector 0 back again and verify contents
208	Read first available track starting at sectors 7 for two sectors and verify contents
210	At first available track sector 29 write four sectors of second pattern* causing track to change
213	Write first available track sector 0 with second pattern
214	At sector 29 read 4 sectors and compare data
216	Read back and verify sector 0
218	Write 129 words on sector 0 of first available track, data chain, write another 129 words
219	Read 129 words on sector 0 of first available track, data chain, read another 129 words
220	Write 150 words on first available track sector 0
221	Read 150 words on first available track sector 0

*Worst case patterns used are: 066666_8, 133333_8, 111111_8, 155555_8.

Table 1. Test Steps (Continued)

Step Number	Function
	Section 2 (Continued)
222	Write 10 words, data chain, write another 10 words from first available track
223	Read 258 words, check fill from first available track sector 0
224	Write 1 word, data chain, write another word from first available track sector 0
225	Read back and check for fill 258 words from sector 0
226	From first available track sector 0 write 2 words, data chain, write 2 more words
227	Read back 258 words and check for fill
228	Write 127 words, data chain, write 127 more words from first available track sector 0
229	Read back 258 words and check for fill
230	Write 128 words, data chain, write another 128 words from first available track sector 0
231	Read back 258 words and check for fill
234	Write 130 words on first available track sector 0
235	Read back 258 words and check for fill
	Section 3
301	At sector 0 of first available track write worst case pattern with CRC (cyclic redundancy check) enabled
302	Read back sector 0 and check for CRC error
303	Read sector 7 with CRC enabled (sector 7 was written with CRC disabled in step 204) and verify status bit 4, CRC check failed (step 204 called by this step)
304	Write first available track sector 5 for 5 sectors (CRC enabled) with 5 worst case data patterns
305	Read sector 5 for 5 sectors (CRC disabled) and verify that expected CRC was generated during step 304
306	At sector 29 write 4 sectors of first available track with CRC enabled using pattern 3
307	At sector 29 read 4 sectors and verify contents written in step 306

Table 1. Test Steps (Continued)

Step Number	Function
	Section 4
401	Write on sector 1 and read sector 3 on first available track verifying that this occurred on the same disc revolution (repear this action 1024 times)
407	Test SIN CPU instruction to insure that it causes disc logic to interrupt
	Section 5
501	Write all surfaces except write protected tracks with worst case data patterns; read back and verify contents; Repeat for each of the 5 worst case data patterns; the first word of each sector will be the sector number and the second word of each sector will be the track address; the device is alternately written forward and backward. If a verify error occurs, retry procedure will be used for sectors containing error, The sectors in error are reread and verified 100 times. Message E005 is printed.
	Section 6
502	Format entrie disc from first available track with 4 worst case data patterns; first word of each sector will contain sector number; second word of each sector will contain track address; remainder of each sector will contain a worst case data pattern according to the following scheme If remainder of S/4 = 0, then pattern 1 If remainder of S/4 = 1, then pattern 2 If remainder of S/4 = 2, then pattern 3 If remainder of S/4 = 3, then pattern 4; where S is the Sector number
503	Randomly write and read a variable number of sectors (1 to 4), each write to be followed by a read and each read to be followed by a compare of expected data (repeat action 1024 times). If there is a compare error, retry procedure will be used. The sectors in error are reread and verified 100 times. Message E005 is printed.

Table 1. Test Steps (Continued)

Step Number	Function
	Section 6 (Continued)
610	This step prints "END OF PASS n" and rotates data patterns, i.e., pattern 5 becomes pattern 1, pattern 1 becomes pattern 2, etc. This is always the last step executed in the diagnostic, whatever sections are executed.
602	Step 602 writes and reads entire disc with random data from first available track to last available track. As much of the disc as possible is written and read in 10 track increments, the remainder of the disc is written and read in 1 track increments.
604	Step 604 writes track addresses on each track from first available track to last available track then reads and compares the addresses. The disc is written and read forward then backwards.
	Section 7
701	Write 31 sectors on first available track and jump back to write continuously; the user is instructed to turn power off, then on; the program hangs in a TIO loop waiting for DISC NOT READY; when this occurs, it waits for DISC READY; when DISC READY occurs, the entire disc is read and checked for CRC errors. At most, one CRC error should be detected (the user may have to repeat test a few times to get CRC error, since power off/on dequence might have been performed too early or late for disc write activity). CRC error track is corrected.
702	Read 31 sectors on the first available track and jump back to read continuously; user is instructed to turn power off and then on again; the program hangs in a TIO loop waiting for DISC NOT READY; when this occurs, it waits for DISC READY; when that occurs, the entire disc is read and checked for CRC errors. No CRC errors should be detected.

STATUS AND ERROR DETECTION

The diagnostic program monitors status of the fixed head disc.
Wherever status is not as expected, the user is notified via a
diagnostic message.

Status

The Status Register contains information that can be requested by the
CPU. Under normal conditions, the Normal Status Word (NSW) is avail-
able. Two other status words, Error Status Words (ESW1 and ESW2), are
available under error conditions. Status word formats are shown in
Figure 1.

```
        0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15
```

NSW	Status Register		Arc Address 1
ESW1	Status Register		Arc Address 2
ESW2	S	Track Address	

Figure 1. Status Words

Status Register, bits 0 through 9, hold the disc status.

Bit	Meaning
0	SIO allowed. This bit will be 1 if the FHDC is in a state where it will accept an SIO-command. It will be 0 if (1) An I/O program is currently running on the controller, (2) the disc is not up to speed or not ready for other reasons. (3) an interrupt (not masked off) is pending.
1	RIO/WIO allowed. Always 0.
2	Interrupt Request. This bit will be 1 also if the interrupt is masked off.
3	Disc not ready.

Bit   Meaning

4   CRC check failed. Note: This check takes place at the
        beginning of the following sector. This means that the
        Arc Address will be pointing to the arc after, and also
        the Track Address will have been incremented if the error
        occurred in the last sector of a track and transfer would
        have continued on the next track.

5   Abort. Will be set if an error occurs.

6   Transfer error. This bit will be set if an irregularity
        in the timing causes loss of data. It will also be set
        by External Transfer Error (parity error on the data bus)
        or CRC error.

7   Track address outside bounds. The validity of the track
        address will be tested after the Write or Read order has
        been issued.

8   Write reject. Will be set if an attempt is made to write
        on a protected track.

9   Arc address outside bounds. If no match takes place be-
        tween the Arc Counter and the Arc Address register after
        one full revolution, then the arc address (loaded by the
        Control order) is outside bounds. The FHDC will set this
        error bit if no match has been found after two Track Origin
        pulses (index marks on the disc).

Arc Address 1 holds are currently under the heads (rotational
position of the disc).

Arc Address 2 holds arc where error occurred.

S holds the first four bits of the Status Register (see above).

Track Address holds track where error occurred.

Cyclic Redundancy Check

The fixed head disc contains a Cyclic Redundancy Check (CRC) genera-

tor. During writing, it processes the data for every sector and

generates a CRC word. This word is then written in the sector. Dur-

ing read, the CRC generator processes the data read from disc and

verifies CRC value. If CRC value is incorrect, disc enters error state.

MESSAGE ANALYSIS

Messages are sent to the operator via the control console. All messages have the following format: a letter prefix; a three digit decimal number, and text, if any. The letter prefix indicates the class of the message. There are four message classes.

Message Class	Meaning
D	Data information which requires no operator input.
P	Diagnostic program has paused, waiting for operator action.
E	Error message which indicates disc or disc controller failure.
Q	Request for operator to perform input via control console.

For D and P class messages, the three digit number indicates message number as described in Table 4. Two possibilities exist for E class messages. If the first digit is non-zero, the three digit number indicates step number where the test failure occurred. If the first digit is zero, interpret three digit number as indicated in Table 4. Error message example:

Message	Meaning
E101	Test failure at step 101
E006 NO RESPONSE TO TIO	Disc does not respond properly to Test I/O instruction

Table 4. Diagnostic Messages

Message	Description
D000 FIXED HEAD DISC DIAG-NOSTIC (HP D428A.XX)	Test preamble.
D006 END OF PASSn	Printed after each pass through diagnostic; n incremented after each printing.

Table 4. Diagnostic Messages (Continued)

Message	Description
D007 HALT AT STEPn	Step HALT option printout (SW.15);n is step number.
D008 HALT AT SECTIONn	Section HALT option printout (SW.9);n is section number.
E001 NSW XXXXXXXXXXXX EXPECTED NSW XXXXXXXXXXXX	Normal status word (NSW) is not as expected; X's hold binary word contents. EXPECTED status only printed when a specific status expected.
E002 ESW1 XXXXXXXXXXXX EXPECTED ESW1 XXXXXXXXXXXX	Error status word one (ESW1) not as expected; X's hold binary word contents. EXPECTED status only printed when a specific status expected.
E003 ESW2 XXXXXXXXXXXX EXPECTED ESW2 XXXXXXXXXXXX	Error status word two (ESW2) not as expected; X's hold binary word contents. EXPECTED status only printed when a specific status expected.
E004 DATA WORDn IS YYY SHOULD BE ZZZZZZZ	The nth data word returned on a read operation holds value YYYYYY instead of proper value ZZZZZZZZZ
E005 100 RETRIES n UNSUCCESSFUL m SUCCESSFUL	Retry report used in steps 501 and 605 when an error is detected. n is the number of unsuccessful read and/or compare combinations; m is the number of successful read/compares.
E006 NO RESPONSE TO TIO	Disc did not respond to Test 1/0 instruction.
E007 NO RESPONSE TO CIO	Disc did not respond to Command 1/0 instruction.
E008 CRC XXXXXXXXXXXX EXPECTED CRC XXXXXXXXXXXX	The Cyclic redundancy check (CRC) is not as expected; X's hold binary value.
E009 NO RESPONSE TO SIO	Disc did not respond to Start 1/0 instruction.
E010 ARC IS XXXXXXXXX EXPECTED ARC XXXXXXXXXXXX	Arc value is not as expected; X's hold binary arc value.
E011 NO INTERRUPT FROM SIN CPU INSTRUC- TION	No interrupt received as expected after SIN instruction executed in CPU.

Table 4. Diagnostic Messages (Continued)

Message	Description
E012 NO INTERRUPT FROM SIO	Start 1/O instruction did not cause interrupt.
E013 NSW IS XXXXXXXXXX SHOULD BE XXXXXXXXXX TRACK = XXX ARC = XXX	Status error in section 6.
E101	Typical step number error printout.
P007 TURN POWER OFF THEN ON	Used in section 7 to test power failure. Turn disc power off and then immediately on again.
P008 ENTER DEVICE NUMBER	Enter 3 decimal digit DRT number.
P009 ENTER FIRST AVAILABLE TRACK	Enter up to 4 digits for decimal number of first available track.
P010 ENTER LAST AVAILABLE TRACK	Enter up to 4 digits for decimal number of last available track.
P011 TURN POWER OFF, PRESS RUN, TURN POWER ON	Used in step 106 to test status bit 3.